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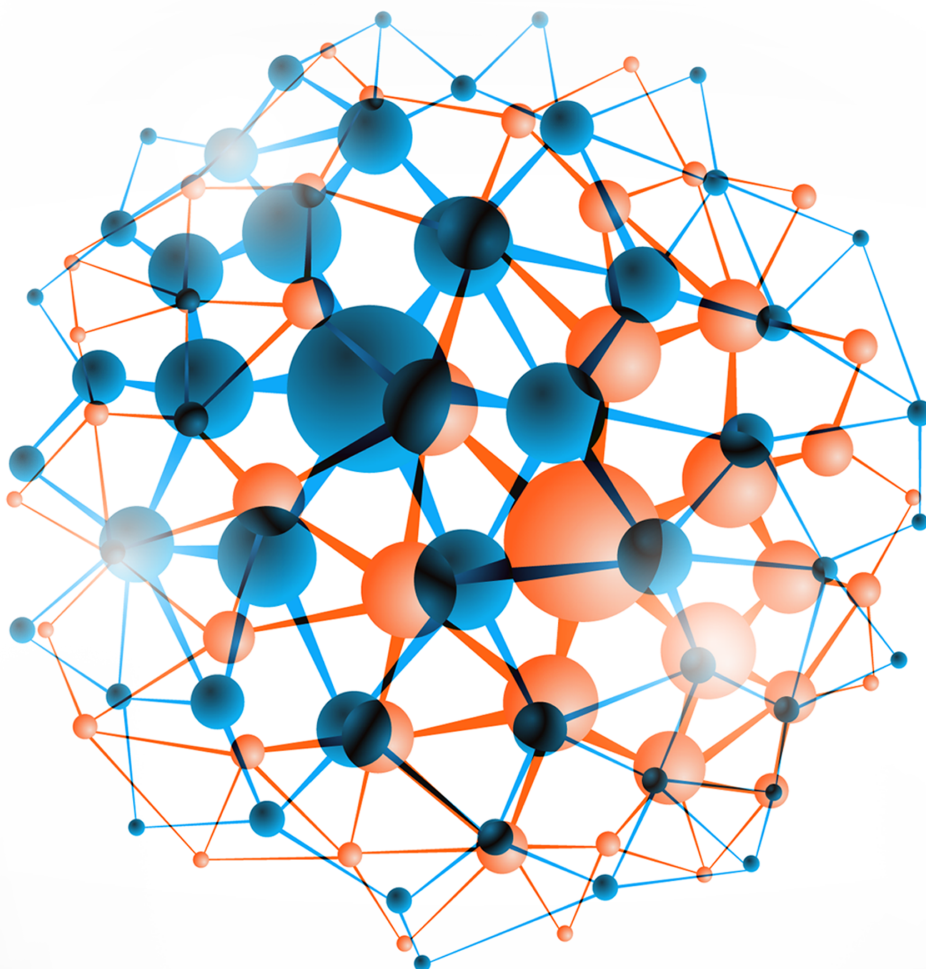
ANNIC 2017

APPLIED NANOTECHNOLOGY AND NANOSCIENCE
INTERNATIONAL CONFERENCE

BOOK OF ABSTRACTS

ROME

Oct 18-20, 2017



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Advanced nanocomposite materials for Oil & Gas production

Friday, 20th October - 13:30 - Poster Session - Hall & Room 3 - Poster - Abstract ID: 528

Ms. Chinyere Okolo¹, Dr. Fawad Inam¹

1. Northumbria University

INTRODUCTION: The search for novel materials has continued to dominate industries like automotive, power, aerospace and energy where maintaining a competitive edge is necessary for increasing industry market share. For subsea applications, where high pressures and temperatures are the norm, using reinforced composites have potential as the next generation solution.

This presentation investigates the influence of micro/nano fillers on mechanical properties of lightweight polymeric materials employed in thermoplastic risers and hoses for subsea applications and the challenge of incorporating such novel materials for potential up-scaling.

To obtain commercially viable microstructures, a two-step processing routes was selected and its influence on final polymer nanocomposite morphology has been studied.

METHODOLOGY: The polymer nanocomposite used in this study consists of carbon nanotubes and HDPE purchased from Nanocyl SA. The pellets were fed into a Brabender single screw laboratory extruder with conditions selected to optimize dispersion and distribution. Filler orientation by shear flow extrusion was achieved by using a rectangular shaped die with unique design and area.

Tensile samples were prepared by punching out dog-shaped dumbbells with die cutter sized-ISO 527-2 5A. Morphology of the fractured surfaces were obtained from the tensile samples examined via FE-SEM (TESCAN MIRA 3; 5KV) after sputter coating (Q150T Turbo-Pumped Sputter Coater) with platinum.

RESULTS: Figure 1 attached compares the Tensile Strength and Young's Moduli of the different concentrations (0%-3%) of carbon nano-tubes in HDPE.

Figure 2 attached shows the micro-graphs of well dispersed 1 wt% CNT in HDPE.

DISCUSSION: By adding approximately 1% by weight (wt%) of carbon nano-tubes, we found the nano-composite to have a Young's modulus of 1.462 ± 0.263 GPa, an increase of about 15% compared to the pure matrix.

Increasing the filler loading to 2% resulted in improved modulus and tensile strength properties without good dispersion. The CNTs can be seen to be bridging cracks in the matrix. The degree of improved dispersion at 1% wt which is demonstrated in FE-SEM images, translated into an improved composite reinforcement.

In summary, the study showed improvements in mechanical properties can be achieved using a two-step processing route. Further studies to develop practical quality control methods are being considered.

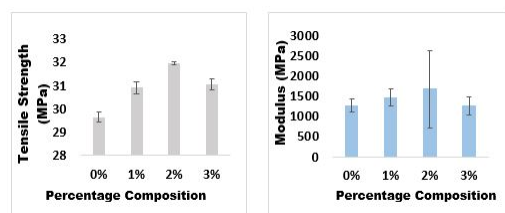


Fig 1. comparison of tensile strength and youngs moduli of 0 -3 carbon nanotubes in hdpe.jpg

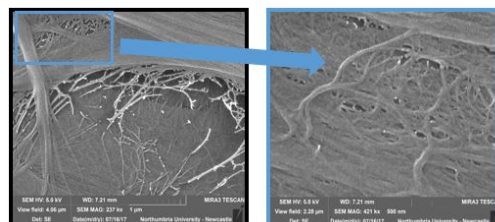


Fig 2. micrographs of 1 wt carbon nanotubes in hdpe.jpg

Advanced nanocomposite materials for subsea oil & gas production.

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Northumbria University, Newcastle upon Tyne



Introduction

The search for novel materials has continued to dominate industries like automotive, power, aerospace and energy where maintaining a competitive edge is necessary for increasing industry market share. For subsea applications, where high pressures and temperatures are the norm, using reinforced composites have potential as the next generation solution. This presentation investigates the influence of micro/nano fillers on mechanical properties of lightweight polymeric materials employed in thermoplastic risers and hoses for subsea applications and the challenge of incorporating such novel materials for potential up-scaling.

To obtain commercially viable microstructures, a two-step processing routes was selected and its influence on final polymer nanocomposite morphology has been studied.

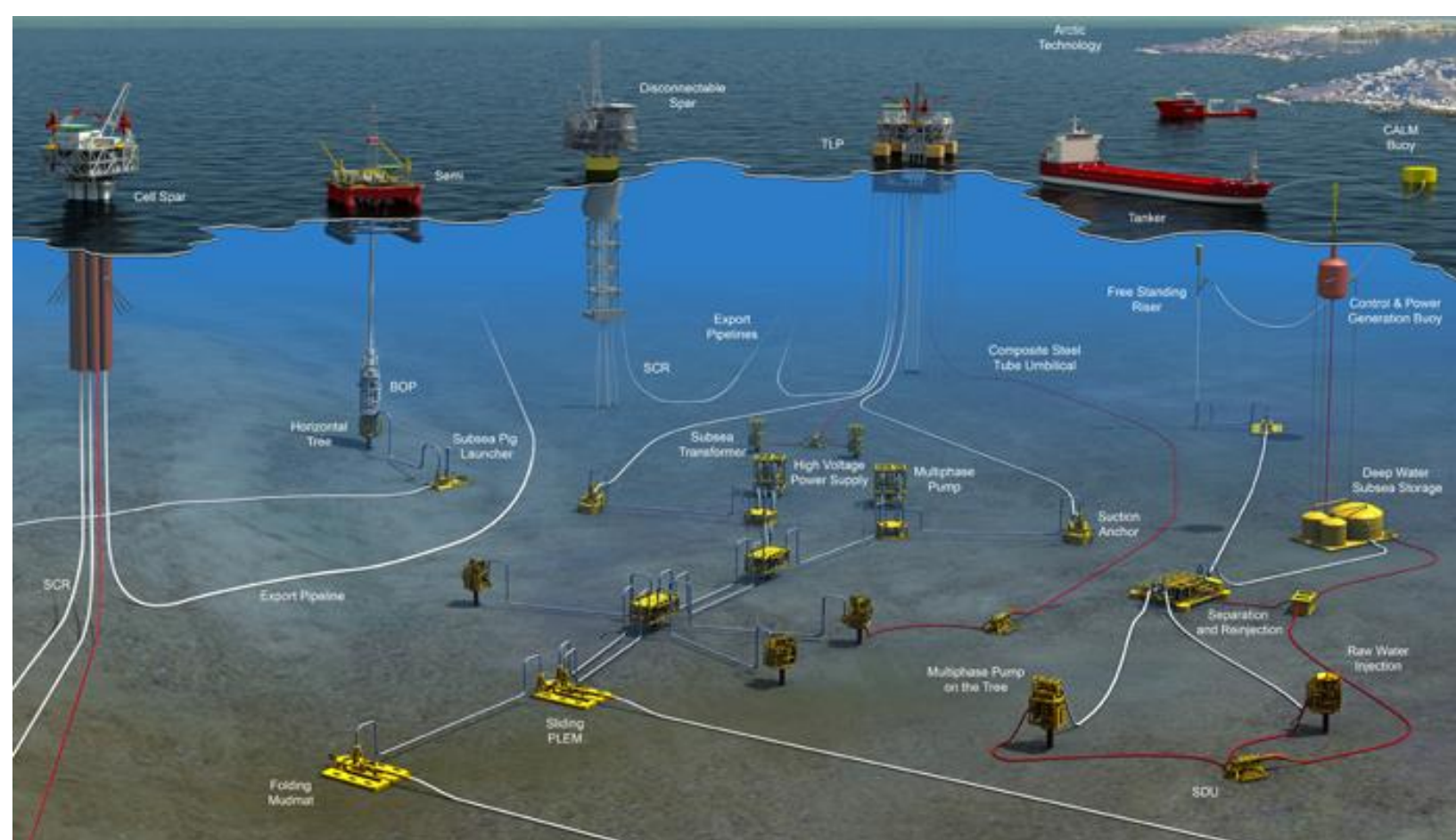


Fig 1: Subsea Field Layout

Commercial Challenges and Barriers

- ✓ Environmental, health and safety.
- ✓ Reproducibility of commercial microstructures.
- ✓ Limited knowledge of long term health effects.

Methodology

The polymer nanocomposite used in this study consists of carbon nanotubes and HDPE purchased from Nanocyl SA. The pellets were fed into a Brabender single screw laboratory extruder with conditions selected to optimize dispersion and distribution. Filler orientation by shear flow extrusion was achieved by using a rectangular shaped die with unique design and area.

Tensile samples were prepared by punching out dog-shaped dumbbells with die cutter sized-ISO 527-2 5A. Morphology of the fractured surfaces were obtained from the tensile samples examined via FE-SEM (TESCAN MIRA 3; 5KV) after sputter coating (Q150T Turbo-Pumped Sputter Coater) with platinum.

Results and Discussions

The mechanical properties of the neat HDPE and CNT-HDPE nanocomposites are shown below. By adding approximately 1wt% of carbon nanotubes, we found the polymer nanocomposite to have a Young's modulus of 1.462 ± 0.263 GPa, an increase of about 15% compared to the pure matrix.

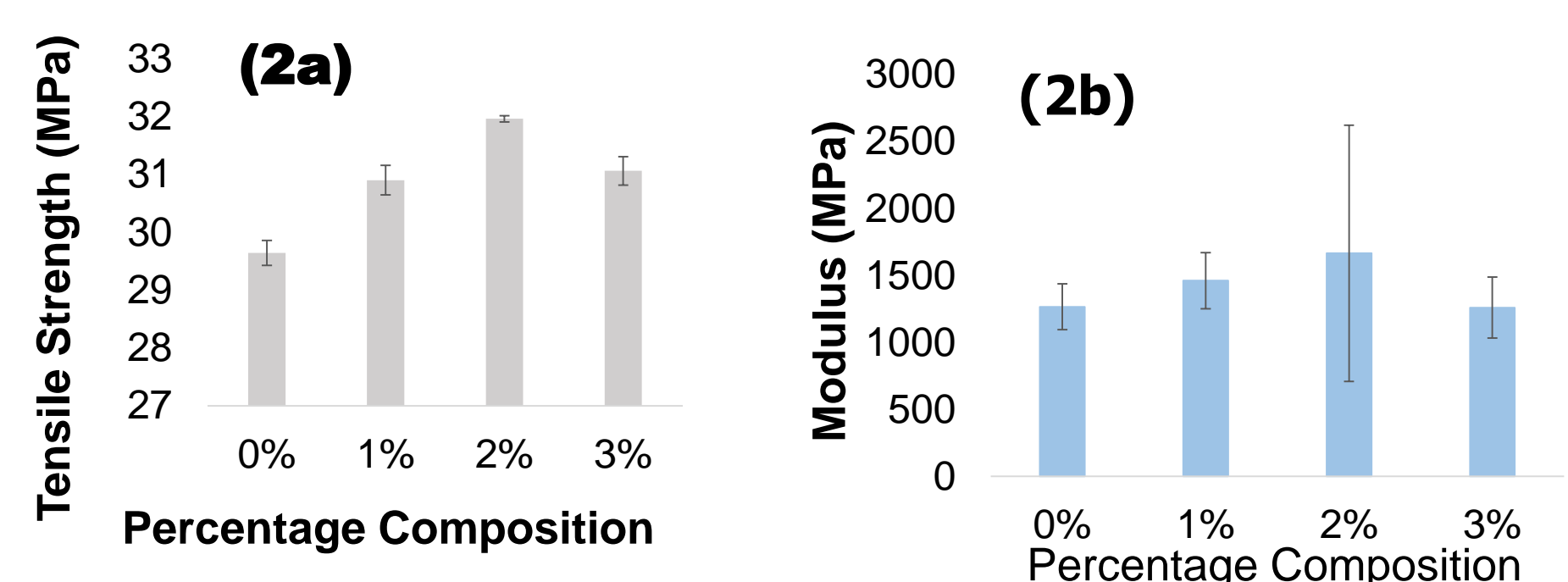
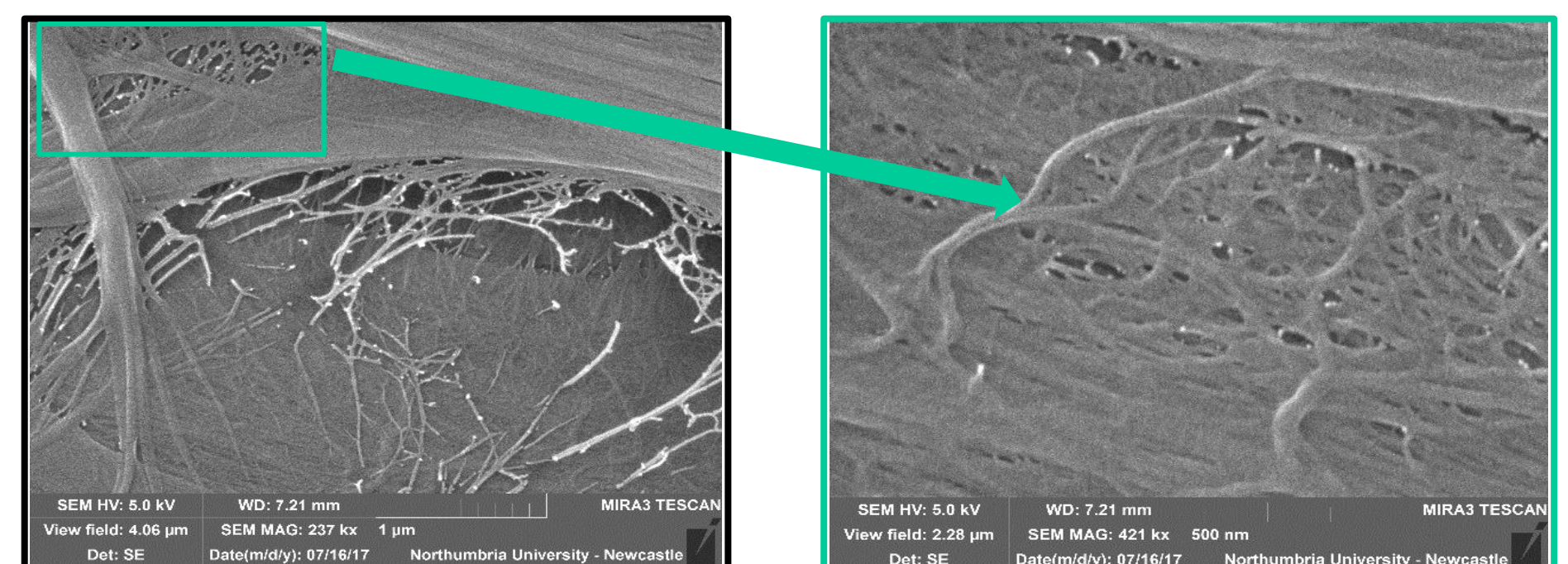


Fig 2a. Tensile Strength of HDPE/CNT concentrations

Fig 2b. Young's Moduli of HDPE/CNT concentrations



- ✓ Increasing the filler loading at 2% resulted in improved modulus and tensile strength properties without good dispersion.
- ✓ The degree of dispersion at 1% wt which is demonstrated in FE-SEM images, translated into an improved composite reinforcement.

Conclusion

In summary improvements in mechanical properties can be achieved using a two-step processing route.

Further investigations to develop practical quality control methods and reproducibility of microstructures are being considered.

References

- [1] Christopher M. White, Richard Banks, Ian Hamertonc, John F. Watts. Characterisation of commercially CVD grown multi-walled carbon nanotubes for paint applications. Progress in Organic Coatings 90 (2016); 44–53.
- [2] Inam et al., Compos. Sci. Technol. 2010. DOI:10.1016/j.compscitech.2010.02.010
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